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(54) [Title of the Invention] METHOD OF MANUFACTURING A COLOR LIQUID CRUYSTAL DISPLAY DEVIICE

(57) [Abstract]

[Object] There is provided a color liquid crystal display device of high quality and a reliability without unevenness in distance between substrates

[Structure] In a method of a color liquid crystal display device, one part is fabricated in the following steps: (1) coating an organic layer for light-shielding over a light-shielding area of a transparent substrate and further over a display area of the transparent substrate so as to have openings corresponding to respective pixels; (2) coating color filter for first pixels is coated over the display area; (3) etching the color filter for the first pixels to leave its parts on the openings for the first pixels; (4) coating a second color filter for second pixels over the display area and the light-shielding area on such a condition as becoming a film-thickness thinner than the coating condition of the color filter for the first pixels in an area except a pixel area; and (5) etching the color filter for the second pixels to leave its parts on the light-shielding area and the opening for the second pixels.

[Claims for Patent]

[Claim 1] A method of manufacturing a color liquid crystal display device having a liquid crystal layer composed of a display area and a light-shielding area surrounding an outer periphery of the display area, through the step of putting one part, which is fabricated in the following steps (1) to (7), on the other part in which transparent electrodes in stripe shape are arranges on a transparent substrate:

(1) coating an organic layer for light-shielding over a light-shielding area of a transparent substrate and further coated over a display area of the transparent

subetrate so as to have openings corresponding to respective pixels;

(2) coating a color filter for first pixels coated at least over the display area;

(3) etching the color filter for the first pixels to leave its parts on the openings for the first pixels;

(4) coating a second color filter for second pixels over the display area and the light-shielding area on such a condition as becoming a film-thickness thinner than the coating condition of the color filter for the first pixels in an area except a pixel area;

(5) etching the color filter for the second pixels to leave its parts on the light-shielding layer of the light-shielding area and the opening for the second pixels;

(6) forming an insulating film over the display area and the light-shielding area; and

(7) arranging and forming transparent electrodes in a stripe shape on the insulating film on the display area.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a method of manufacturing a color liquid crystal display device in which a polymer layer for light-shielding is provided over the outer periphery of a display area.

[0002]

[Prior Art] Although a color liquid crystal display device employing a color filter has been proposed, this color liquid crystal display device is manufactured by a technique wherein a photosensitive colored filter containing a pigment such as red, green or blue is coated on a transparent substrate and a fine color filter is then formed in a grid or column shape by photolithography, such technique being called ordinarily "pigment distributing method". (Refer to Japanese Kokai Patent Publication Hei 58-102976) The manufacturing method of the color filter in the color liquid crystal display device will be described with reference to Fig. 4 to Fig. 8.

[0003] In Fig.4, 1 is a transparent substrate such a glass, and a light-shielding layer 2 is formed on this transparent substrate 1. In case of forming the light-shielding layer 2 in a grid shape, each grid point corresponds to the individual pixel.

[0004] As shown in Fig. 5, a photosensitive over which a pigment such as red is distributed, is next coated over the entire surface by the printing or the spin-coating, and by exposing and developing by use of a mask, red pixels 5 (R) are formed as shown in Fig. 6.

[0005] Further, by repeating this step on other pixels for green and blue,

green pixels 6 (G) and blue pixels 7 (B) are formed as shown in Fig. 7.

[0006] Next, as shown in Fig. 8, acrylic resin layer 8 is coated in order to make unevenness by the respective pixels 5, 6, and 7 smooth, and transparent electrodes 9 are formed on the resin layer 8, so that one liquid crystal display substrate is completed.

[0007] Thus, the one liquid crystal display substrate and the other liquid crystal display substrate, which is fabricated by forming transparent electrodes on a transparent subsrate, are put on together via liquid crystal to constitute a display area.

[0008] In the meantime, in the above color liquid crystal display device, it is proposed such a construction that the color filters employed in the display area and the light-shielding layer are formed with surrounding the outer periphery of the display area (refer to Japanese Kokai Patent Publication Hei 1-299917 and Japanese Kokai Patent Publication 2-287429). In such color filter forming method, there are tow methods, one of which is to form a metal layer such as chromium by the evaporation or sputtering, followed by patterning by photolithography, and the other of which is to form and pattern a photosensitive resin containing materials having a black color pigment, the latter method having been recently paid attention in view of the material costs and so on.

[0009]

[Problem to be Solved by the Invention] However, The thickness of the organic light-shielding layer is about 1 to 2 μm and is thus about 10 to 20 times as large as the light-shielding layer made of the conventional inorganic metal thin film, and for this reason constituting the outer peripheral area of the display area by forming a color filter on the organic light-shielding layer causes such a problem as shown in Fig. 9.

[0010] This figure is a partial cross-sectional view of liquid crystal device, in which 10 is a glass substrate and in this substrate 10, 11 is a display area and 12 is a outer peripheral area of the display area 11. In the display area 11, a display light-shielding layer 13 made of an organic film is patterned in a predetermined shape and an outer peripheral light-shielding layer 14 is formed over by the same organic film, and further as described with reference to Fig. 4 to Fig. 8, the photosensitive resin layers containing the respective red, green and blue pigments are coated on the display area 11 to form the respective pixels R, G and B. In addition, simultaneously with forming the respective pixels R, G and B, dummy pixels R, G and B are formed on the outer peripheral light-shielding layer 14.

[0011] Thereafter, an planing layer 15 is covered over the display area 12 and the outer peripheral area 12, and further a transparent electrode (not shown) is formed on the planing layer 15.

[0012] However, in the color liquid crystal display device of the above constitution, the organic light-shielding layers 13 and 14 whose thickness is very large as compared to the conventional light-shielding layer made of the inorganic metal thin film are formed, and for this reason, the influence due to that thickness can be ignored.

[0013] That is, since the dummy pixels R, G and B are formed on the outer peripheral light-shielding layer 14 above the outer peripheral area 12, the height becomes large by the distance d corresponding to the light-shielding layer 14, so that when the glass substrate 10 and the opposite glass substrate are put on together, such problems take place that the distance between the substrates are not uniform, or the transparent electrodes are broken down.

[0014] Therefore, in the color liquid crystal display device of the above construction, in particular a display device of an STN method being required to strictly uniform the distance between the substrates, the unevenness in the distance provides the deviation on the display screen resulting in the deterioration in display.

[0015]

[Means for Solving the problems] The method for manufacturing a color liquid crystal display device according to the present invention is characterized by providing a liquid crystal layer with a display area and a light-shielding area surrounding an outer periphery of the display area, through the step of putting one part, which is fabricated in the following steps (1) to (7), on the other part in which transparent electrodes in stripe shape are arranges on a transparent substrate:

[0016] (1) coating an organic layer for light-shielding over a light-shielding area of a transparent substrate and further coated over a display area of the transparent substrate so as to have openings corresponding to respective pixels;

(2) coating a color filter for first pixels coated at least over the display area;

(3) etching the color filter for the first pixels to leave its parts on the openings for the first pixels;

(4) coating a second color filter for second pixels over the display area and the light-shielding area on such a condition as becoming a film-thickness thinner than the coating condition of the color filter for the first pixels in an area except a pixel area;

(5) etching the color filter for the second pixels to leave its parts on the light-shielding layer of the light-shielding area and the opening for the second pixels;
(6) forming an insulating film over the display area and the light-shielding area; and
(7) arranging and forming transparent electrodes in a stripe shape on the insulating film on the display area.

[0017]

[Operation] In the manufacturing method of the color liquid crystal display device of the above construction, it is paid to attention that the thickness upon coating the color filter for the second pixel on the display area trends to become thinner than that of the color filter for the first pixels which has been already coated on the display area, and therefore, coating the thinner color filter for the second pixels on the display area can suppress the fact that the thickness of the light-shielding area becomes large as compared to that of the display area, so that the distance between the put-on substrates is made uniform over that substrate surface. As a result, in the display device of the STN method, the deviation of the display screen is prevented to present a good image.

[0018]

[Embodiments] In the following, the detailed description will be made on the embodiments of the present invention employing three color filters with reference to Fig. 1 to Fig. 3, Fig. 10 and Fig. 11.

[0019] (Embodiment 1) The color liquid crystal display device 16 according to the present embodiment will be described with reference to Fig. 1 to Fig. 3. Fig. 1 is main cross section diagram of the color liquid crystal display device 16, Fig. 2 is a main enlarged diagram of the display device 16, and Fig. 3 is a plan view of the display device 16.

[0020] In manufacturing the color liquid crystal display device 16, the producing steps of the color filters are the same as the description made with reference to Fig. 4 to Fig. 8. However, as a light-shielding layer, a photosensitive resin containing carbon black (CK-2000 made by Fuji Photograph Film) is used throughout the embodiments.

[0021] Further adding the main points of the fabricating method of the color filter, after cleaning the glass substrate 17 coated by silica, the above photosensitive resin containing carbon black is coated and thereafter exposed and developed to form a display light-shielding layer 19 having a thickness of 0.8 μm on the display area 18 in a predetermined pattern as well as a outer peripheral light-shielding layer 21 having the same thickness over the outer peripheral area 20. The size of the display area 18 is 192 x 144 mm, and

contrarily the width of the outer peripheral area 20 is about 5 mm.

[0022] Subsequently, a photosensitive resin containing a red pigment is coated over the entire surface (the spinning rotation speed being 350 r.p.m.) and is then exposed through a mask to form red pixels (R) having a thickness of about 1.8 μm.

[0023] Next, a photosensitive resin containing a green pigment is coated over the entire surface (the concentration and viscosity of this resin being the same as the above photosensitive resin containing the red pigment, but its the spinning rotation speed being 400 r.p.m.) and is then exposed through a mask to form green pixels (G) having a thickness of about 1.8 μm. In this case, the thickness trend to be small as the rotation speed is made large; however, since the resin is formed so as to fill the gaps between the adjacent red pixels, the similar thickness is obtained even in the rotation rate being made large.

[0024] Thereafter, a photosensitive resin containing a blue pigment is coated over the entire surface (the concentration and viscosity of this resin being the same as the above photosensitive resin containing the red pigment, but its the spinning rotation speed being 450 r.p.m.) and is then exposed through a mask to form blue pixels (G) having a thickness of about 1.8 μm, and simultaneously, this blue color filter is further formed on the outer peripheral area 21 in a predetermined pattern. Also in the blue pixels (B), the similar thickness is obtained even in the rotation rate being made large, but on the contrary, in the dummy pixel 22 formed on the outer peripheral area 20, since there is no filling function obtained upon the formation of the blue pixels (B), its thickness becomes small as the rotation speed is made large, resulting in obtaining about 1 μm thickness.

[0025] Incidentally, in this embodiment, as resins for the above color filters, photosensitive resins, CR-2000, CG-2000, and CB-2000 each containing a pigment are used which are made by Fuji Photograph Film.

[0026] Thereafter, a protection layer 23 made of an acrylic resin is laminated in thickness of about 2 μm. Next, a transparent conductive layer (not shown) is deposited in thickness of 2000 A on the substrate. The transparent conductive layer thus formed on the color filters is pattern in a stripe shape by photolithography to form transparent electrodes. The pixel pitch of the color filter is 0.3 mm and the line width of the transparent electrode is 275 μm.

[0027] As an opposite substrate, after a transparent conductive layer is formed on a transparent substrate with a thickness of 2000 A, a stripe pattern is formed similarly by photolithography. These two substrates are face with

each other, and their peripheries are sealed for the injection of liquid crystal, so that a color liquid crystal display device is completed.

[0028] According to the color liquid crystal display device 16 thus obtained, the distance between the out-on substrates can be made uniform, so that particularly in a display device of the STN type, the deviation in the display screen is prevented to present a good image.

[0029] (Embodiment 2) A color display device 24 according to the present embodiment is shown in Fig. 10 and Fig. 11. Fig. 10 is a partial cross section view of this color liquid crystal display device, and Fig. 11 is a main enlargement view of the display device 24.

[0030] The manufacturing method of the color liquid crystal display device 24 is the same process as the color liquid crystal display device according to the embodiment 1, but in this color liquid crystal display device 24, in place of the patterned dummy pixel 22, a dummy color filter 25 is coated to be formed over the outer peripheral area 20. Incidentally, the same constituents as those of the color liquid crystal display device are denoted by the same reference numerals.

[0031] Thus, also in the above constructed color liquid crystal display device 24, the distance between the out-on substrates can be made uniform, so that particularly in a display device of the STN type, the deviation in the display screen is prevented to present a good image without the breakdown of the transparent electrodes.

[0032] (Embodiment 3) Although the display light-shielding layer 19 and the outer peripheral light-shielding layer 21 in the color liquid crystal display device according to the embodiment 1 are both 0.8 μm in thickness, in the color liquid crystal display device according to the present embodiment, both of them are made to be 1.0 μm in thickness expect for the other conditions being the same as each other.

[0033] Thus, according to the present color liquid crystal display device, before laminating the protection layer 23 made of an acrylic resin, the outer peripheral area 20 is larger in thickness by about 0.2 μm than the display area 18, but by laminating the protection layer 23 to be 2 μm in thickness, the difference in thickness between the display area 18 and the outer peripheral area 20 becomes lower than 0.1 μm to present no practical problem. Thus, the distance between the out-on substrates can be made uniform, so that particularly in a display device of the STN type, the deviation in the display screen is prevented to present a good image.

[0034] The present inventors have confirmed, through the plural times of

experiences with respect to the thickness of the respective pixels (g), (R), and (B), that by making the range of its thickness to be 1.0 to 2.5 μm, preferably, 1.4 to 2.2 μm, improvements are made in the characteristics such as transmittance, color purity and uniformity. In addition, as for the protection layer 23 made of an acrylic resin, the range of its thickness is to be 1.0 to 3.5 μm, preferably 1.5 to 2.5 μm with respect to the improvement in evenness.

[0035] The present invention is not limited to the above embodiments, but may changed and modified without departing from the scope of the present invention. For example, although the color filters in the embodiments is three kinds. tow or four kinds or more kinds may be applicable.

[0036]

[Effects of the Invention] As described above, according to the manufacturing method of the color liquid crystal display device of the present invention, the thickness upon coating the color filter for the second pixel on the display area trends to become thinner than that of the color filter for the first pixels which has been already coated on the display area. whereby coating the thinner color filter for the second pixels on the display area can compensate the fact that the thickness of the light-shielding area becomes large as compared to that of the display area, so that the distance between the put-on substrates is made uniform over that substrate surface. As a result, in the display device of the STN method, the deviation of the display screen is prevented to present a good image without the breakdown of the transparent electrodes.

[Brief Description of Drawings]

[Fig. 1] Main cross section view of a color liquid crystal display device of the embodiment.

[Fig. 2] Main enlargement view of a color liquid crystal display device of the embodiment.

[Fig. 3] Plan view of a color liquid crystal display device of the embodiment.

[Fig. 4] Process step view of the color liquid crystal display device.

[Fig. 5] Process step view of the color liquid crystal display device.

[Fig. 6] Process step view of the color liquid crystal display device.

[Fig. 7] Process step view of the color liquid crystal display device.

[Fig. 8] Process step view of the color liquid crystal display device.

[Fig. 9] Main cross section view of a conventional color liquid crystal display device.

[Fig. 10] Main cross section view of another conventional color liquid crystal display device.

[Fig. 11] Main cross section view of another conventional color liquid crystal display device.

[Explanation of the Reference Numerals]

R	Red pixel
G	Green pixel
B	Blue pixel
17	Glass substrate
18	Display area
19	Display light-shielding layer
20	Outer peripheral area
21	Outer peripheral light-shielding area
22	Dummy pixel

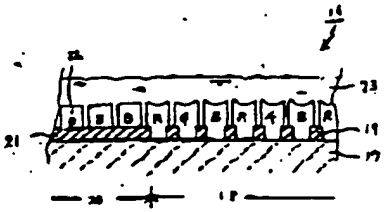
7

21 外周用遮光膜
22 ダミー用画素

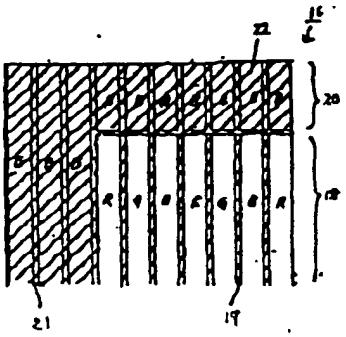
8

25 ダミー用カラーフィルター

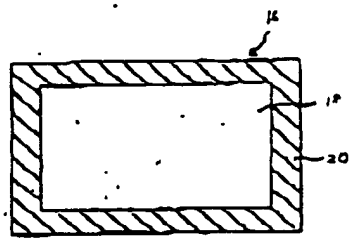
【図1】 Fig.1



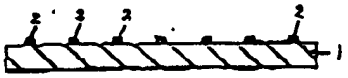
【図2】 Fig.2



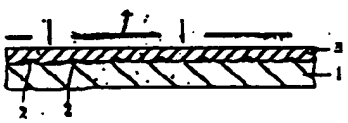
【図3】 Fig.3



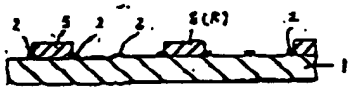
【図4】 Fig.4



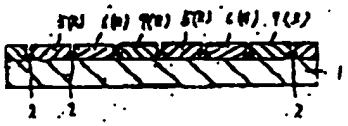
【図5】 Fig.5



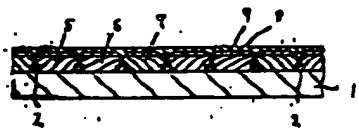
【図6】 Fig.6



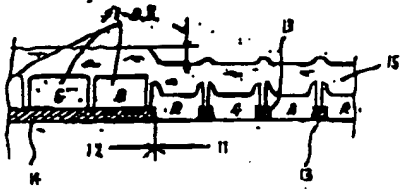
【図7】 Fig.7



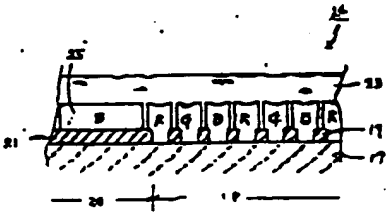
【図8】 Fig.8



Dummy Pixels [図9] Fig. 9



[図10] Fig. 10



[図11] Fig. 11